REMARKS

Reconsideration of the rejection of all claims is respectfully requested in view of the above amendments and the following remarks.

Claim Amendments

Claims 1 and 12 have been amended to limit the scope A, B and D to certain preferred embodiments as discussed below, and claims 6-10 have been cancelled to be consistent with the amendments to claim 1. Claims 1-5 and 12-14 have been amended to more appropriately and consistently recite "or a pharmaceutically-acceptable salt thereof." The dependency of each of claims 4, 5, 11, 16 and 18 has been amended to eliminate improper multiple dependencies. Claims 15 and 17 have been cancelled as being in a "use" format, not generally acceptable in U.S. practice. All amendments and claim cancellations are made without prejudice to applicants' right to prosecute any subject matter thereby deleted in one or more continuing applications.

Following entry of these amendments, claims 1-5, 11-14, 16 and 18 remain pending in this application.

Specification

The specification has been amended to insert reference to the status of this application being the section 371 national phase of international application PCT/GB99/01308 filed April 27, 1999, as requested by the Examiner, although it is understood by the undersigned that this recitation is no longer required.

Obviousness-Type Double Patenting Rejection

All claims have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-11 of U.S. Patent No. 6,300,330

(hereinafter "the '330 Patent"). This rejection is respectfully traversed in view of the above claim amendments, the enclosed declaration of Peter William Rodney Caulkett (herinafter the "Caulkett Declaration") and the following remarks.

First of all, applicants confirm that the subject matter and the inventions claimed in the '330 Patent and in the present application were owned by the same person or subject to an obligation of assignment to the same person at the time that the respective inventions were made. Specifically, at the time the respective inventions were made in the period of 1997 to 1999, the inventors thereof were under obligations of assignment to Zeneca Ltd. Subsequently, the rights to these applications/patents merged into AstraZeneca, where they are now commonly held. Therefore, pursuant to 35 U.S.C. § 103(c), the '330 Patent does not preclude patentability of the present invention under subsection (e), (f) and/or (g) of section 103, *even if* the respective claimed inventions are not patentably distinct. However, for the reasons discussed below, it is respectfully submitted that the presently claimed invention is patentably distinct from the invention claimed in the '330 Patent so as to preclude even the obviousness-type double patenting rejection.

The '330 Patent generically claims a compound of the formula (I):

$$A—B—X^1—T^1(R^2)—L^1—T^2(R^3)—X^2—Q$$

as defined in the claims, and various sub-genus thereof. The present claims define a small group of compounds that fall within the broad generic scope of the '330 Patent claims, which compounds are neither suggested or particularly described in the '330 patent claims, even when read in context of the specification.

In particular, ring "Q" in the above formula of the '330 patent is defined in claim 1 as being "phenyl, naphthyl, phenylC_{1-4}alkyl, phenylC_{2-4}alkenyl, phenylC_{2-4}alkynyl or a

heterocyclic moiety containing up to 4 heteroatoms selected from nitrogen, oxygen and sulphur." The narrower sub-genus of claim 7 of the '330 Patent defines ring "Q" as being "styryl or naphthyl optionally substituted by fluoro, chloro or bromo or is phenyl optionally substituted by fluorophenyl, chlorophenyl, or bromophenyl."

In contrast, corresponding ring "D" in the compounds of the present application is limited to a "2-indolyl." It is respectfully submitted that the specific selection of 2-indolyl from the broad genus of claim 1, even when considered in light of the supporting specification disclosure, is not taught or suggested by the '330 patent claims, particularly in light of the narrower selection of styryl or naphthyl rings in the narrower genus of claim 7. Moreover, there is no suggestion that the selection of specifically a 2-indolyl from the broad genus would yield compounds with particularly advantageous properties, as established by the attached Caulkett Declaration.

Specifically, the Caulkett Declaration compares the Factor Xa inhibitory activity of two compounds of the present application (compounds of Examples 3 and 9, wherein D is a 2-indolyl) against the otherwise corresponding compound of Example 12 of the '330 Patent (which is also Example 1 of the present application) wherein Q (or D) is a 2-benzofuranyl.[1]

[1] A inadvertent clerical error was noted in the present specification during preparation of the Caulkett Declaration. Specifically, at page 14, lines 15 to 16, it is stated that "Example 1 showed an IC_{50} in test a) of 0.005μM and in test b) a CT2 (PT) against human thrombin of 15μM." It is now apparent that this passage should in fact refer to Example 9 of the present application, as verified by the attached Caulkett Declaration. It is apparent that this error arose because the text was taken directly from the second UK priority application, UK Patent Application No. 9903337.5, filed on 16 February 1999, where this compound was in fact, Example 1. A copy of the 2nd priority application is attached hereto for convenience of reference, where this same reference to data from Example 1 appears at page 15, lines 26-27. However, in that 2nd UK priority application, Example 1 is 1-(5-Bromoindol-2-ylsulphonyl)-4-[4-(4-pyridyl)benzoyl]piperazine, which became Example 9 of the present application as filed (see present specification at page 23). This error does not affect the patentability of this application, inasmuch as test data for disclosed compounds can be introduced into the record during prosecution to establish, *e.g.*, unexpected results as in the present Caulkett Declaration. However, applicants would be happy to correct or delete the erroneous statement at page 14, lines 15-16 of the present specification by amendment in order to avoid possible confusion, if the Examiner is in agreement, and hereby authorize the Examiner to do so by Examiner's amendment if he deems it appropriate.

The compounds were tested for Factor Xa inhibitory activity using the method of test a) and test b) described in the present application at page 12, and in the '330 Patent at column 13. The results are summarized on the following table:

Example	D or Q ring	Test a) [IC50]	Test b) [IC50 human PT]
Present #3	5-chloroindol-2-yl	0.005μM (1)	12μM (2)
Present #9	5-bromoindol-2-yl	0.005μM	15μM (2)
"330 Patent #12	2-chlorobenzofuran-2-yl	0.057μM	35μM (2)

(1) Average of 3 measurements
(2) Average of 2 measurements

As noted in paragraph 6 of the Caulkett Declaration, this increased potency was unexpected.

In view of the comparative data presented with the Caulkett Declaration and the above remarks, *even if* the presently claimed compounds are considered *prima facia* obvious over the claims of the '330 Patent, it is respectfully submitted that the obviousness-type double patenting rejection as been overcome.

Claim Rejections – 35 USC § 112

Claims 6-18 have been rejected under section 35 U.S.C. § 112 on various formal grounds, including improper multiple dependency and "use" format. It is believed that each of these grounds for rejection has been overcome by the above corrective amendments or claim cancellation.

Conclusion

In view of the above amendments, the attached Caulkett Declaration and the foregoing remarks, it is believed that all grounds for objection and rejection raised by the Examiner have been met and overcome. Accordingly, it is respectfully submitted that all claims are in condition for allowance, and a notice to that effect is respectfully solicited.

EXCEPT for issue fees payable under 37 C.F.R. § 1.18, the Director is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. §§ 1.16 and 1.17 which may be required, including any required extension of time fees, or credit any overpayment to Deposit Account 50-0310. This paragraph is intended to be a **CONSTRUCTIVE PETITION FOR EXTENSION OF TIME** in accordance with 37 C.F.R. § 1.136(a)(3).

Respectfully Submitted,
Morgan Lewis & Bockius LLP

Date: December 2, 2003 By: _____

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Text & 2nd Priority Document
UK 9903337.5
16-2-99

HETEROCYCLIC DERIVATIVES

The invention relates to heterocyclic derivatives, or pharmaceutically-acceptable salts thereof, which possess antithrombotic and anticoagulant properties and are accordingly useful in methods of treatment of humans or animals. The invention also relates to processes for the preparation of the heterocyclic derivatives, to pharmaceutical compositions containing them and to their use in the manufacture of medicaments for use in the production of an antithrombotic or anticoagulant effect.

The antithrombotic and anticoagulant effect produced by the compounds of the invention is believed to be attributable to their strong inhibitory effect against the activated coagulation protease known as Factor Xa. Factor Xa is one of a cascade of proteases involved in the complex process of blood coagulation. The protease known as thrombin is the final protease in the cascade and Factor Xa is the preceding protease which cleaves prothrombin to generate thrombin.

Certain compounds are known to possess Factor Xa inhibitory properties and the field has been reviewed by R.B. Wallis, Current Opinion in Therapeutic Patents, 1993, 1173-1179. Thus it is known that two proteins, one known as antistatin and the other known as tick anticoagulant protein (TAP), are specific Factor Xa inhibitors which possess antithrombotic properties in various animal models of thrombotic disease.

It is also known that certain non-peptidic compounds possess Factor Xa inhibitory properties. Of the low molecular weight inhibitors mentioned in the review by R.B. Wallis, all possessed a strongly basic group such as an amidinophenyl or amidinonaphthyl group.

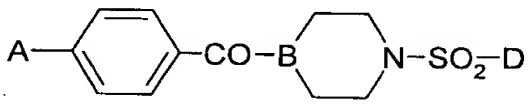
We have now found that certain heterocyclic derivatives possess Factor Xa inhibitory activity. Many of the compounds of the present invention also possess the advantage of being selective Factor Xa inhibitors, that is the enzyme Factor Xa is inhibited strongly at concentrations of test compound which do not inhibit or which inhibit to a lesser extent the enzyme thrombin which is also a member of the blood coagulation enzymatic cascade.

The compounds of the present invention possess activity in the treatment or prevention of a variety of medical disorders where anticoagulant therapy is indicated, for example in the treatment or prevention of thrombotic conditions such as coronary artery and cerebro-vascular disease. Further examples of such medical disorders include various

cardiovascular and cerebrovascular conditions such as myocardial infarction, the formation of atherosclerotic plaques, venous or arterial thrombosis, coagulation syndromes, vascular injury including reocclusion and restenosis following angioplasty and coronary artery bypass surgery, thrombus formation after the application of blood vessel operative techniques or after general surgery such as hip replacement surgery, the introduction of artificial heart valves or on the recirculation of blood, cerebral infarction, cerebral thrombosis, stroke, cerebral embolism, pulmonary embolism, ischaemia and angina (including unstable angina).

The compounds of the invention are also useful as inhibitors of blood coagulation in an ex-vivo situation such as, for example, the storage of whole blood or other biological samples suspected to contain Factor Xa and in which coagulation is detrimental.

Accordingly in one aspect the present invention provides compounds of formula (I)



(I)

wherein:

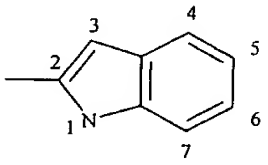
A is an optionally substituted 5- or 6-membered monocyclic aromatic ring containing 1, 2 or 3 ring heteroatoms selected from nitrogen, oxygen and sulphur atoms;

the 1,4-phenylene ring is optionally substituted;

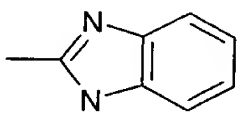
B is CH or N (preferably B is N);

D is optionally substituted 2-indolyl, 2-benzimidazolyl, 2-benzo[b]furanyl, 2-pyrrolo[2,3-b]pyridyl, 2-furo[2,3-b]pyridyl or 6-7H-cyclopenta[b]pyridyl; and pharmaceutically acceptable salts thereof.

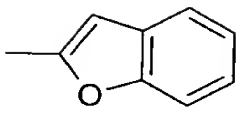
For the avoidance of doubt substituents C are drawn below:

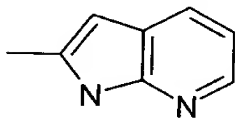


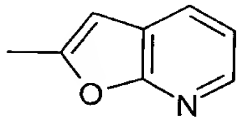
2-indolyl

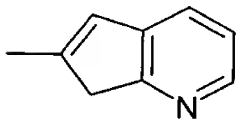


2-benzimidazolyl

2-benzo[b]furanyl 

2-pyrrolo[2,3-b]pyridyl 

2-furo[2,3-b]pyridyl 

6-7H-cyclopenta[b]pyridyl 

In this specification the term "alkyl" includes both straight and branched chain alkyl groups but references to individual alkyl groups such as "propyl" are specific for the straight chain version only. An analogous convention applies to other generic terms.

It is to be understood that certain heterocyclic derivatives of the present invention can exist in solvated as well as unsolvated forms such as, for example, hydrated forms. It is to be understood that the invention encompasses all such solvated forms which possess Factor Xa inhibitory activity.

It is further to be understood that, insofar as certain of the compounds of the formula defined above may exist in optically active or racemic forms by virtue of one or more asymmetric carbon atoms, the invention encompasses any such optically active or racemic form which possesses Factor Xa inhibitory activity. The synthesis of optically active forms may be carried out by standard techniques of organic chemistry well known in the art, for example by synthesis from optically active starting materials or by resolution of a racemic form.

Preferably A is an optionally substituted 5- or 6-membered monocyclic aromatic ring containing 1, 2 or 3 ring nitrogen atoms. Preferably A is a pyridyl, pyrimidinyl, imidazolyl or pyridazinyl ring for example 2-pyridyl, 3-pyridyl, 4-pyridyl, 3-pyradazinyl, 4-pyridazinyl, 4-pyrimidinyl, 5-pyrimidinyl, 1-imidazolyl, 2-imidazolyl or 4-imidazolyl. Of these 4-pyrimidinyl, 4-pyridazinyl, 1-imidazolyl, 4-imidazolyl, 4-pyridyl are preferred.

In one aspect A is unsubstituted. In another aspect A is substituted by one, two or three atoms or groups selected from halo (for example fluoro, chloro or bromo), oxo, carboxy, trifluoromethyl, cyano, amino, hydroxy, nitro, C_{1-4}alkyl (for example methyl or ethyl), C_{1-4}alkoxy (for example methoxy or ethoxy), C_{1-4}alkoxycarbonyl, C_{1-4}alkylamino (for example methylamino or ethylamino), di-C_{1-4}alkylamino (for example dimethylamino or diethylamino) or amino C_{1-4}alkyl (for example aminomethyl or aminoethyl). For the avoidance of doubt susbstituents on A may also be present, where possible, on the heteroatom of the ring, such as, for example, N-oxides. Preferred substituents are C_{1-4}alkyl, oxo, amino and halo. Preferably substituents are C_{1-4}alkyl, amino and halo. Preferably A is unsubstituted.

In one aspect the 1,4-phenylene ring of a compound of formula I is unsubstituted. In another aspect the 1,4-phenylene ring of a compound of formula I is substituted by one or two substituents selected from halo, trifluoromethyl, trifluoromethoxy, cyano, nitro, C_{1-4}alkyl, C_{2-4}alkenyl and C_{2-4}alkynyl, from the substituent $-(CH_2)_n Y^1$ wherein n is 0-4 and Y^1 is selected from hydroxy, amino, carboxy, C_{1-4}alkoxy, C_{2-4}alkenyloxy, C_{2-4}alkynyloxy, C_{1-4}alkylamino, di-C_{1-4}alkylamino, pyrrolidin-1-yl, piperidino, morpholino, thiomorpholino, 1-oxothiomorpholino, 1,1-dioxothiomorpholino, piperazin-1-yl, 4-C_{1-4}alkylpiperazin-1-yl, C_{1-4}alkylthio, C_{1-4}alkylsulphinyl, C_{1-4}alkylsulphonyl, C_{2-4}alkanoylamino, benzamido, C_{1-4}alkylsulphonamido and phenylsulphonamido, from the substituent $-(CH_2)_n Y^2$ wherein n is 0-4 and Y^2 is selected from carboxy, carbamoyl, C_{1-4}alkoxycarbonyl, N-C_{1-4}alkylcarbamoyl, N,N-di-C_{1-4}alkylcarbamoyl, pyrrolidin-1-ylcarbonyl, piperidinocarbonyl, morpholinocarbonyl, thiomorpholinocarbonyl, 1-oxothiomorpholinocarbonyl, 1,1-dioxothiomorpholinocarbonyl, piperazin-1-ylcarbonyl, 4-C_{1-4}alkylpiperazin-1-ylcarbonyl, C_{1-4}alkylsulphonamidocarbonyl, phenylsulphonamidocarbonyl and benzylsulphonamidocarbonyl, from a substituent of the formula $-X^3-L^2-Y^2$ wherein X^3 is a group of the formula $CON(R^5)$, $CON(L^2-Y^2)$, $C(R^5)_2O$, O, $N(R^5)$ or $N(L^2-Y^2)$, L^2 is C_{1-4}alkylene, Y^2 has any of the meanings defined immediately hereinbefore and each R^5 is independently hydrogen or C_{1-4}alkyl, and from a substituent of the formula $-X^3-L^3-Y^1$ wherein X^3 is a group of the formula $CON(R^5)$, $CON(L^3-Y^1)$, $C(R^5)_2O$, O, $N(R^5)$ or $N(L^3-Y^1)$, L^3 is C_{2-4}alkylene, Y^1 has any of the meanings defined immediately hereinbefore and each R^5 is independently hydrogen or C_{1-4}alkyl, and wherein any heterocyclic group in a substituent of the 1,4-phenylene ring of compounds of formula I optionally bears 1 or 2 substituents selected from carboxy, carbamoyl, C_{1-4}alkyl, C_{1-4}alkoxycarbonyl, N-C_{1-4}alkylcarbamoyl and N,N-di-C_{1-}

$_{4}$alkylcarbamoyl, and wherein any phenyl group in a substituent of the 1,4-phenylene ring of compounds of formula I optionally bears 1 or 2 substituents selected from halo, trifluoromethyl, cyano, C_{1-4}alkyl, C_{2-4}alkenyl, C_{2-4}alkynyl, C_{1-4}alkoxy, C_{2-4}alkenyloxy and C_{2-4}alkynyloxy. Preferably the 1,4-phenylene ring of a compound of formula I is substituted by carboxy, C_{1-4}alkoxy or C_{1-4}alkoxycarbonyl. Preferably the 1,4-phenylene ring of a compound of formula I is unsubstituted.

In one aspect the heterocyclic ring containing B is unsubstituted. In another aspect this ring is substituted by one or two substituents selected from hydroxy, oxo, carboxy and C_{1-4}alkoxycarbonyl; or one of the following:

$-(CH_2)_n$-R, $-(CH_2)_n$-NRR^1, -CO-R , -CO-NRR^1, $-(CH_2)_n$-CO-R and $-(CH_2)_n$-CO-NRR^1; wherein n is 0, 1 or 2, preferably n is 1 or 2;

R and R^1 are independently selected from hydrogen, C_{1-4}alkyl, C_{2-4}alkenyl, C_{2-4}alkynyl, hydroxyC_{1-4}alkyl, carboxyC_{1-4}alkyl and C_{1-4}alkoxycarbonylC_{1-4}alkyl or where possible R and R^1 may together form a 5- or 6-membered optionally substituted saturated or partially unsaturated (preferably saturated) heterocyclic ring which may include in addition to the nitrogen to which R and R^1 are attached 1 or 2 additional heteroatoms selected from nitrogen, oxygen and sulphur.

In a particular aspect the heterocyclic ring formed by R and R^1 is preferably selected from 1-pyrrolidinyl, 1-imidazolinyl, 1-piperidino, 1-piperazinyl, 4-morpholino and 4-thiomorpholino. In a particular aspect the heterocyclic ring formed by R and R^1 may be unsubstituted. In an alternative aspect the ring formed by R and R^1 is substituted by 1 or 2 substituents selected from oxo, hydroxy and carboxy. Preferably the heterocyclic ring containing B is substituted by oxo, carboxy, C_{1-4}alkoxy or C_{1-4}alkoxycarbonyl. Preferably the heterocyclic ring containing B is unsubstituted.

In one aspect D is unsubstituted. In another aspect D is substituted by one, two or three substituents selected from halo, trifluromethyl, trifluoromethoxy, cyano, hydroxy, oxo, amino, nitro, trifluoromethylsulphonyl, carboxy, carbamoyl, C_{1-4}alkyl, C_{2-4}alkenyl, C_{2-4}alkynyl, C_{1-4}alkoxy, C_{2-4}alkenyloxy, C_{2-4}alkynyloxy, C_{1-4}alkylthio, C_{1-4}alkylsulphinyl, C_{1-4}alkylsulphonyl, C_{1-4}alkylamino, di-C_{1-4}alkylamino, C_{1-4}alkoxycarbonyl, N-C_{1-4}alkylcarbamoyl, N,N-di-C_{1-4}alkylcarbamoyl, C_{2-4}alkanoyl, C_{2-4}alkanoylamino, hydroxyC_{1-4}alkyl, C_{1-4}alkoxyC_{1-4}alkyl, carboxyC_{1-4}alkyl, C_{1-4}alkoxycarbonylC_{1-4}alkyl, carbamoylC_{1-4}alkyl, N-C_{1-4}alkylcarbamoylC_{1-4}alkyl, N,N-di-C_{1-4}alkylcarbamoylC_{1-4}alkyl, phenyl, heteroaryl,

phenoxy, phenylthio, phenylsulphinyl, phenylsulphonyl, benzyl, benzoyl, heteroaryloxy, heteroarylthio, heteroarylsulphinyl and heteroarylsulphonyl, and wherein said heteroaryl substituent or the heteroaryl group in a heteroaryl-containing substituent is a 5- or 6-membered monocyclic heteroaryl ring containing up to 3 heteroatoms selected from nitrogen, oxygen and sulphur, and wherein said phenyl, heteroaryl, phenoxy, phenylthio, phenylsulphinyl, phenylsulphonyl, heteroaryloxy, heteroarylthio, heteroarylsulphinyl, heteroarylsulphonyl, benzyl or benzoyl substituent optionally bears 1, 2 or 3 substituents selected from halo, trifluoromethyl, cyano, hydroxy, amino, nitro, carboxy, carbamoyl, C_{1-4}alkyl, C_{1-4}alkoxy, C_{1-4}alkylamino, di-C_{1-4}alkylamino, C_{1-4}alkoxycarbonyl, N-C_{1-4}alkylcarbamoyl, N,N-di-C_{1-4}alkylcarbamoyl and C_{2-4}alkanoylamino. Preferably D is substituted by halo. Preferably the halo substituent is cromo or chloro and preferably at the 5-position, as numbered on the indole ring.

Suitable values for optional substituents for the 1,4-phenylene ring and C of compounds of formula I are:

for C_{1-4}alkyl:	methyl, ethyl and propyl;
for C_{1-4}alkoxycarbonyl:	methoxycarbonyl, ethoxycarbonyl, propoxycarbonyl and tert-butoxycarbonyl;
for N-C_{1-4}alkylcarbamoyl:	N-methylcarbamoyl, N-ethylcarbamoyl and N-propylcarbamoyl;
for N,N-di-C_{1-4}alkylcarbamoyl:	N,N-dimethylcarbamoyl, N-ethyl-N-methylcarbamoyl and N,N-diethylcarbamoyl;
for hydroxyC_{1-4}alkyl:	hydroxymethyl, 1-hydroxyethyl, 2-hydroxyethyl and 3-hydroxypropyl;
for C_{1-4}alkoxyC_{1-4}alkyl:	methoxymethyl, ethoxymethyl, 1-methoxymethyl, 2-methoxyethyl, 2-ethoxyethyl and 3-methoxypropyl;
for carboxyC_{1-4}alkyl:	carboxymethyl, 1-carboxyethyl, 2-carboxyethyl and 3-carboxypropyl;
for C_{1-4}alkoxycarbonylC_{1-4}alkyl:	methoxycarbonylmethyl, ethoxycarbonylmethyl, tert-butoxy-

carbonylmethyl, 1-methoxycarbonylethyl, 1-ethoxycarbonylethyl, 2-methoxycarbonylethyl, 2-ethoxycarbonylethyl, 3-methoxycarbonylpropyl and 3-ethoxycarbonylpropyl;

for carbamoylC_{1-4}alkyl: carbamoylmethyl, 1-carbamoylethyl, 2-carbamoylethyl and 3-carbamoylpropyl;

for N-C_{1-4}alkylcarbamoylC_{1-4}alkyl: N-methylcarbamoylmethyl, N-ethylcarbamoylmethyl, N-propylcarbamoylmethyl, 1-(N-methylcarbamoyl)ethyl, 1-(N-ethylcarbamoyl)ethyl, 2-(N-methylcarbamoyl)ethyl, 2-(N-ethylcarbamoyl)ethyl and 3-(N-methylcarbamoyl)propyl;

for N,N-di-C_{1-4}alkylcarbamoyl-C_{1-4}alkyl: N,N-dimethylcarbamoylmethyl, N-ethyl-N-methylcarbamoylmethyl, N,N-diethylcarbamoylmethyl, 1-(N,N-dimethylcarbamoyl)ethyl, 1-(N,N-diethylcarbamoyl)ethyl, 2-(N,N-dimethylcarbamoyl)ethyl, 2-(N,N-diethylcarbamoyl)ethyl and 3-(N,N-dimethylcarbamoyl)propyl;

for halo: fluoro, chloro, bromo;

for C_{1-4}alkoxy: methoxy, ethoxy;

for C_{1-4}alkylamino: methylamino, ethylamino;

for di-C_{1-4}alkylamino: dimethylamino, diethylamino;

for C_{1-4}alkenyl: vinyl and allyl;

for C_{2-4}alkynyl: ethynyl and prop-2-ynyl;

for C_{2-4}alkenyloxy: vinyloxy and allyloxy;

for C_{2-4}alkynyloxy:	ethynyloxy and prop-2-ynyloxy;
for C_{1-4}alkylthio:	methylthio, ethylthio and propylthio;
for C_{1-4}alkylsulphinyl:	methylsulphinyl, ethylsulphinyl and propylsulphinyl;
for C_{1-4}alkylsulphonyl:	methylsulphonyl, ethylsulphonyl and propylsulphonyl;
for C_{2-4}alkanoyl;	formyl, acetyl, proprionyl or butyryl;
for C_{2-4}alkanoylamino:	acetamido, propionamido and butyramido;

A preferred class of compounds of the present invention is that wherein:

A is pyridyl, pyrimidinyl, imidazolyl or pyridazinyl;

B is N;

C is 2-indolyl, or 2-benzo[b]furanyl optionally substituted by fluoro, chloro or bromo;

and pharmaceutically-acceptable salts thereof.

Particular compounds of the invention include:

1-(5-bromoindol-2-ylsulphonyl)-4-[4-(4-pyridyl)benzoyl]piperazine, and

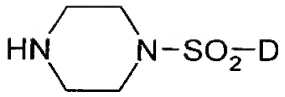
1-(5-chloroindol-2-ylsulphonyl)-4-[4-(6-oxo-1H-pyridazin-3-yl) benzoyl]piperazine; and pharmaceutically-acceptable salts thereof.

A heterocyclic derivative of formula I, or pharmaceutically-acceptable salt thereof, may be prepared by any process known to be applicable to the preparation of related compounds. Such procedures are provided as a further feature of the invention and are illustrated by the following representative processes in which, unless otherwise stated A, B, and D have any of the meanings defined hereinbefore wherein any functional group, for example amino, alkylamino, carboxy or hydroxy, is optionally protected by a protecting group which may be removed when necessary.

Necessary starting materials may be obtained by standard procedures of organic chemistry and by reference to the processes used in the Examples.

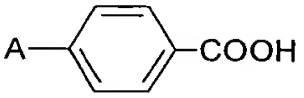
According to another aspect, the present invention provides a process for preparing a compound of formula (I) or a pharmaceutically acceptable salt thereof, which comprises:

(a) For the production of those compounds of the formula (I) wherein B is N, the reaction, conveniently in the presence of a suitable base, of an amine of formula (II)



(II)

with an acid of the formula (III)



(III)

or a reactive derivative thereof.

A suitable reactive derivative of an acid of the formula (III) is, for example, an acyl halide, for example an acyl chloride formed by the reaction of the acid and an inorganic acid chloride, for example thionyl chloride; a mixed anhydride, for example an anhydride formed by the reaction of the acid with a chloroformate such as isobutyl chloroformate or with an activated amide such as 1,1'-carbonyldiimidazole; an active ester, for example an ester formed by the reaction of the acid and a phenol such as pentafluorophenol, an ester such as pentafluorophenyl trifluoroacetate or an alcohol such as N-hydroxybenzotriazole or N-hydroxysuccinimide; an acyl azide, for example an azide formed by the reaction of the acid and an azide such as diphenylphosphoryl azide; an acyl cyanide, for example a cyanide formed by the reaction of an acid and a cyanide such as diethylphosphoryl cyanide; or the product of the reaction of the acid and a carbodiimide such as N,N'-dicyclohexylcarbodiimide or N-(3-dimethylaminopropyl)-N'-ethyl-carbodiimide.

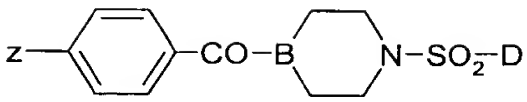
The reaction is conveniently carried out in the presence of a suitable base such as, for example, an alkali or alkaline earth metal carbonate, alkoxide, hydroxide or hydride, for example sodium carbonate, potassium carbonate, sodium ethoxide, potassium butoxide, sodium hydroxide, potassium hydroxide, sodium hydride or potassium hydride, or an organometallic base such as an alkyl-lithium, for example n-butyl-lithium, or a dialkylamino-lithium, for example lithium di-isopropylamide, or, for example, an organic amine base such as, for example, pyridine, 2,6-lutidine, collidine, 4-dimethylaminopyridine, triethylamine, morpholine or diazabicyclo[5.4.0]undec-7-ene. The reaction is also preferably carried out in a suitable inert solvent or diluent, for example methylene chloride, chloroform, carbon tetrachloride, tetrahydrofuran, 1,2-dimethoxyethane, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidin-2-one, dimethylsulphoxide or acetone, and at a temperature in the range, for example, -78° to 150°C, conveniently at or near ambient temperature.

A suitable protecting group for an amino or alkylamino group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an alkoxycarbonyl group, for example a methoxycarbonyl, ethoxycarbonyl or tert-butoxycarbonyl group, an arylmethoxycarbonyl group, for example benzyloxycarbonyl, or an aroyl group, for example benzoyl. The deprotection conditions for the above protecting groups necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or alkoxycarbonyl group or an aroyl group may be removed for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an acyl group such as a tert-butoxycarbonyl group may be removed, for example, by treatment with a suitable acid such as hydrochloric, sulphuric, phosphoric acid or trifluoroacetic acid and an arylmethoxycarbonyl group such as a benzyloxycarbonyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon, or by treatment with a Lewis acid for example boron tris(trifluoroacetate). A suitable alternative protecting group for a primary amino group is, for example, a phthaloyl group which may be removed by treatment with an alkylamine, for example dimethylaminopropylamine, or with hydrazine.

A suitable protecting group for a hydroxy group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an aroyl group, for example benzoyl, or an arylmethyl group, for example benzyl. The deprotection conditions for the above protecting groups will necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or an aroyl group may be removed, for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. An arylmethyl group such as a benzyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

A suitable protecting group for a carboxy group is, for example, an esterifying group, for example a methyl or an ethyl group which may be removed, for example, by hydrolysis with a base such as sodium hydroxide, or for example a tert-butyl group which may be removed, for example, by treatment with an acid, for example an organic acid such as trifluoroacetic acid, or for example a benzyl group which may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

(b) The reaction of a compound of the formula (IV):



(IV)

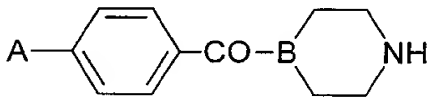
wherein Z is a displaceable group such as halo, with an activated derivative of ring A. Suitable activated derivatives include metalised derivatives, such as with zinc or tin, and borane derivatives. The activated derivative of ring A is reacted with a compound of the formula (IV) to effect cross coupling where Z is triflate or a halo group, such as iodo, bromo or chloro. Suitably the reaction is catalysed by use of a transition state metal catalyst, such as palladium, for example tetrakis (triphenylphosphine) palladium (0).

Alternatively it is possible that ring A contains the displaceable group Z and the phenyl ring is activated, and the reaction performed as described above.

Compounds of the formula (IV) not suitable for this method are those which contain a halo substituent on any of the rings.

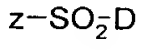
(c) By forming A ring on compounds of formula (IV), wherein Z is a functional group capable of cyclisation. Suitable reagents and conditions are described below in preparing compounds of formula (III) by cyclisation.

(d) The reaction of a compound of the formula (V):



(V)

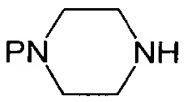
with a compound of the formula (VI):



(VI)

wherein Z is a displaceable group for example chloro, under conditions similar to those of process (a) above.

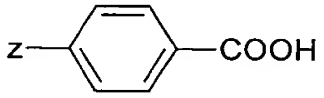
Compounds of formula (II) wherein B is N may be prepared by the reaction of a compound of the formula (VII)



(VII)

, wherein P is a protecting group, with a compound of formula (VI), as defined above, in an analogous manner as described above in method (d) above, and subsequently removing the protecting group.

Compounds of formula (III) may be prepared by the coupling of a compound of formula (VIII), wherein Z is a displaceable group, preferably halo,



(VIII)

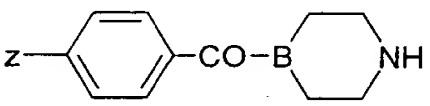
with an activated derivative of ring A as described, for example, in method (b) above. Ideally the reaction is catalysed with a palladium catalyst. Suitable reagents and conditions are described in Martin A.R.; Acta.Chem.Scand., 47, 221-230, (1993); Mitchell T.N.; Synthesis, 803, (1992) and Stille, J.K., Angew. Chem. Int. Ed. Engl. 25, 508-524, (1986).

Suitable non-catalysed coupling reactions include those described in Shiao, M-J. et. al., Synlett., 655, (1992).

Synthesis of stannane intermediates which may be required for palladium catalysed reactions are described in Hylarides, M.D. et. al., Journal of Organometallic Chemistry, 367, 259-265, (1989).

Alternatively compounds of formula (III) may be prepared by forming A rings on compounds of formula (VIII), wherein Z is a functional group capable of cyclisation, by cyclisation reaction. Suitable reagents and conditions are described in Bredereck H. Chem.Ber.; 96, 1505, (1963); Fuchigami, T., Bull. Chem. Soc. Jpn., 49, p3607, (1976); Huffman, K.R., J. Org. Chem., 28, p1812, (1963); Palusso, G., Gazz. Chim. Ital., 90, p1290, (1960) and Ainsworth C., J.Het.Chem., 3, p470, (1966). Such reactions are particularly suited to the formation of 5-membered A rings. Processes suitable for synthesis of starting materials in such cyclisation reactions are described, for example, in Zhang M.Q. et.al; J.Heterocyclic. Chem.; 28, 673, (1991) and Kosugi, M. et al., Bull. Chem. Soc. Jpn., 60, 767-768 (1987).

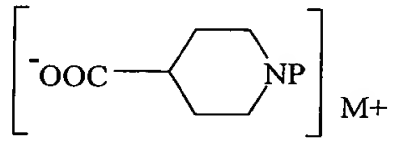
Compounds of formula (IV) may be prepared by the reaction of a compound of the formula (IX)



(IX)

with a compound of formula (VI), as defined above, in an analogous manner as described above in method (c).

Compounds of formula (IX), where B is CH, may be prepared by the reaction of a compound of the formula (X)



(X)

with an activated compound of formula (III')

(III')

wherin Z is a leaving group, such as methyl or chloride, and subsequently effecting removal of the protecting group, as described in Journal of Chemistry, 42, 1189, (1977).

Preferably the compound of formula (VI) is prepared by conversion from the sodium salt of the sulphonic acid or free acid derivative by reacting with thionyl chloride, in the presence of a catalyst, such as dimethyl formamide, in a suitable solvent, such as dichloromethane.

When a pharmaceutically-acceptable salt of a compound of the formula (I) is required, it may be obtained, for example, by reaction of said compound with a suitable acid or base using a conventional procedure.

When an optically active form of a compound of the formula (I) is required, it may be obtained, for example, by carrying out one of the aforesaid procedures using an optically active starting material or by resolution of a racemic form of said compound using a conventional procedure, for example by the formation of diastereomeric salts, use of chromatographic techniques, conversion using chirally specific enzmatic processes, or by additon of temporary extra chiral groupd to aid seperation.

As stated previously, the compounds of the formula (I) are inhibitors of the enzyme Factor Xa. The effects of this inhibition may be demonstrated using one or more of the standard procedures set out hereinafter:-

a) Measurement of Factor Xa Inhibition

An in vitro assay system based on the method of Kettner et al., J. Biol. Chem., 1990, 265, 18289-18297, whereby various concentrations of a test compound are dissolved in a pH7.5 buffer containing 0.5% of a polyethylene glycol (PEG 6000) and incubated at 37°C with human Factor Xa (0.001 Units/ml, 0.3 ml) for 15 minutes. The chromogenic substrate S-2765 (KabiVitrum AB, 20 μM) is added and the mixture is incubated at 37°C for 20 minutes whilst the absorbance at 405 nm is measured. The maximum reaction velocity (Vmax) is determined and compared with that of a control sample containing no test compound. Inhibitor potency is expressed as an IC_{50} value.

b) Measurement of Thrombin Inhibition

The procedure of method a) is repeated except that human thrombin (0.005 Units/ml) and the chromogenic substrate S-2238 (KabiVitrum AB, 7 μM) are employed.

c) Measurement of Anticoagulant Activity

An in vitro assay whereby human, rat or rabbit venous blood is collected and added directly to a sodium citrate solution (3.2 g/100 ml, 9 parts blood to 1 part citrate solution). Blood plasma is prepared by centrifugation (1000 g, 15 minutes) and stored at 2-4°C. Conventional prothrombin time (PT) tests are carried out in the presence of various concentrations of a test compound and the concentration of test compound required to double the clotting time, hereinafter referred to as CT2, is determined. In the PT test, the test compound and blood plasma are incubated at 37°C for 10 minutes. Tissue thromboplastin with calcium (Sigma Limited, Poole, England) is added and fibrin formation and the time required for a clot to form are determined.

d) Rat Disseminated Intravascular Coagulation in vivo activity test:

Fasted male Alderley Park rats (300-450 g) are pre-dosed by oral gavage (5 mls/kg) with compound or vehicle (5% DMSO/PEG200) at various times before being anaesthetised with Intraval® (120 mg/kg i.p.). The left jugular vein and the right carotid artery are exposed and cannulated. A 1 mL blood sample is taken from the carotid canular into 3.2% trisodium citrate. 0.5 mL of the whole blood is then treated with EDTA and used for platelet count determination whilst the remainder is centrifuged (5 mins, 20000g) and the resultant plasma frozen for subsequent drug level, fibrinogen or thrombin antithrombin (TAT) complex determinations. Recombinant human tissue factor (Dade Innovin Cat.B4212-50), reconstituted to the manufacturers specification, is infused (2 mL/kg/hr) into the venous canular for 60

minutes. Immediately after the infusion is stopped a 2 mL blood sample is taken and platelet count, drug level, plasma fibrinogen concentration and TAT complex are determined as before. Platelet counting is performed using at Coulter T540 blood analyser. Plasma fibrinogen and TAT levels are dertermining using a clotting assay (Sigma Cat.880-B) and TAT ELISA (Behring) respectively. The plasma concentration of the compound is bioassayed using human Factor Xa and a chromogenic substrate S2765 (Kabi), extrapolated from a standard curve (Fragmin) and expressed in Anti-Factor Xa units. The data is analysed as follows; tissue factor-induced reductions in platelet count are normalised with respect to pre-dose platelet count and drug activity expressed as a percent inhibition of tissue factor-induced thrombocytopenia when compared to vehicle treated animals. Compounds are active if there is statistically significant ($p < 0.05$) inhibition of TF-induced thrombocytopenia.

e) An ex vivo Assay of Anticoagulant Activity

The test compound is administered intravenously or orally to a group of Alderley Park Wistar rats. At various times thereafter animals are anaesthetised, blood is collected and PT coagulation assays analogous to those described hereinbefore are conducted.

f) An in vivo Measurement of Antithrombotic Activity

Thrombus formation is induced using an analogous method to that described by Vogel et al., Thromb. Research, 1989, 54, 399-410. A group of Alderley Park Wistar rats is anaesthetised and surgery is performed to expose the vena cava. Collateral veins are ligated and two loose sutures are located, 0.7 cm apart, round the inferior vena cava. Test compound is administered intravenously or orally. At an appropriate time thereafter tissue thromboplastin (30 µl/kg) is administered via the jugular vein and, after 10 seconds, the two sutures are tightened to induce stasis within the ligated portion of vena cava. After 10 minutes the ligated tissue is excised and the thrombus therein is isolated, blotted and weighed.

Example 1 showed an IC_{50} in test a) of 0.005µM and in test b) a CT2 (PT) against human thrombin of 15µM.

A feature of the invention is a compound of formula (I), or a pharmaceutically acceptable salt thereof, for use in medical therapy.

According to a further feature of the invention there is provided a pharmaceutical composition which comprises a heterocyclic derivative of formula (I), or a

pharmaceutically-acceptable salt thereof, in association with a pharmaceutically-acceptable diluent or carrier.

The composition may be in a form suitable for oral use, for example a tablet, capsule, aqueous or oily solution, suspension or emulsion; for topical use, for example a cream, ointment, gel or aqueous or oily solution or suspension; for nasal use, for example a snuff, nasal spray or nasal drops; for vaginal or rectal use, for example a suppository; for administration by inhalation, for example as a finely divided powder such as a dry powder, a microcrystalline form or a liquid aerosol; for sub-lingual or buccal use, for example a tablet or capsule; or for parenteral use (including intravenous, subcutaneous, intramuscular, intravascular or infusion), for example a sterile aqueous or oily solution or suspension. In general the above compositions may be prepared in a conventional manner using conventional excipients.

The amount of active ingredient (that is a heterocyclic derivative of the formula (I), or a pharmaceutically-acceptable salt thereof) that is combined with one or more excipients to produce a single dosage form will necessarily vary depending upon the host treated and the particular route of administration. For example, a formulation intended for oral administration to humans will generally contain, for example, from 0.5 mg to 2 g of active agent compounded with an appropriate and convenient amount of excipients which may vary from about 5 to about 98 percent by weight of the total composition. Dosage unit forms will generally contain about 1 mg to about 500 mg of an active ingredient.

According to a further feature of the invention there is provided a heterocyclic derivative of formula (I), or a pharmaceutically-acceptable salt thereof, for use in a method of treatment of the human or animal body by therapy.

The invention also includes the use of such an active ingredient in the production of a medicament for use in:-

(i) producing a Factor Xa inhibitory effect;

(ii) producing an anticoagulant effect;

(iii) producing an antithrombotic effect;

(iv) treating a Factor Xa mediated disease or medical condition;

(v) treating a thrombosis mediated disease or medical condition;

(vi) treating coagulation disorders; and/or

(vii) treating thrombosis or embolism involving Factor Xa mediated coagulation.

The invention also includes a method of producing an effect as defined hereinbefore or treating a disease or disorder as defined hereinbefore which comprises administering to a warm-blooded animal requiring such treatment an effective amount of an active ingredient as defined hereinbefore.

The size of the dose for therapeutic or prophylactic purposes of a compound of the formula (I) will naturally vary according to the nature and severity of the medical condition, the age and sex of the animal or patient being treated and the route of administration, according to well known principles of medicine. As mentioned above, compounds of the formula (I) are useful in the treatment or prevention of a variety of medical disorders where anticoagulant therapy is indicated. In using a compound of the formula (I) for such a purpose, it will generally be administered so that a daily oral dose in the range, for example, 0.5 to 100 mg/kg body weight/day is received, given if required in divided doses. In general lower doses will be administered when a parenteral route is employed, for example a dose for intravenous administration in the range, for example, 0.01 to 10 mg/kg body weight/day will generally be used. For preferred and especially preferred compounds of the invention, in general, lower doses will be employed, for example a daily dose in the range, for example, 0.1 to 10 mg/kg body weight/day. In general a preferred dose range for either oral or parenteral administration would be 0.01 to 10 mg/kg body weight/day.

Although the compounds of formula (I) are primarily of value as therapeutic or prophylactic agents for use in warm-blooded animals including man, they are also useful whenever it is required to produce an anticoagulant effect, for example during the ex-vivo storage of whole blood or in the development of biological tests for compounds having anticoagulant properties.

The compounds of the invention may be administered as a sole therapy or they may be administered in conjunction with other pharmacologically active agents such as a thrombolytic agent, for example tissue plasminogen activator or derivatives thereof or streptokinase. The compounds of the invention may also be administered with, for example, a known platelet aggregation inhibitor (for example aspirin, a thromboxane antagonist or a thromboxane synthase inhibitor), a known hypolipidaemic agent or a known anti-hypertensive agent.

The invention will now be illustrated in the following Examples in which, unless otherwise stated:-

(i) yields are given for illustration only and are not necessarily the maximum attainable;

(ii) the end-products of the formula (I) have satisfactory microanalyses and their structures were confirmed by nuclear magnetic resonance (NMR) and mass spectral techniques (MS). Chemical shift values were measured on the delta scale; the following abbreviations have been used: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet;

(iii) intermediates were not generally fully characterised and purity was assessed by thin layer chromatographic, infra-red (IR) or NMR analysis; and

(iv) melting points were determined using a Mettler SP62 automatic melting point apparatus or an oil-bath apparatus; melting points for the end-products of the formula I were generally determined after crystallisation from a conventional organic solvent such as ethanol, methanol, acetone, ether or hexane, alone or in admixture.

Example 1

1-(5-Bromoindol-2-ylsulphonyl)-4-[4-(4-pyridyl)benzoyl]piperazine

By a method analogous to that described in Example 3 of GB9809351.1 starting from 4-(4-pyridyl)benzoic acid (199 mg, 1 mmol) and 1-(5-bromoindol-2-ylsulfonyl) piperazine (344 mg, 1 mmol, 1 mol eq.), was prepared 1-(5-bromoindol-2-ylsulphonyl)-4-[4-(4-pyridyl)benzoyl]piperazine methane sulphonic acid salt, (155mg), ^{1}H NMR (d_6-DMSO) 2.3 (s, 3H), 3.0-3.3 (broad d, 4H), 3.4-3.8 (broad d, 4H), 7.0 (d, 1H), 7.45 (s, 2H), 7.6 (d, 2H), 7.95 (s, 1H), 8.0 (d, 2H), 8.25 (d, 2H), 8.9 (d, 2H), 12.4 (s, 1H), signals were also present due to ethanol (0.15 mol equiv.); MS $(M+H)^+$ 525/527.

Example 2

1-(5-Chloroindol-2-ylsulphonyl)-4-[4-(6-oxo-1H-pyridazin-3-yl) benzoyl]piperazine

By a method analogous to that described in Example 3 of GB9809351.1 starting from 4-(6-oxo-1*H*-pyridazin-3-yl) benzoic acid (302mg, 1.4mmol) and 1-(5-chloroindol-2-ylsulphonyl)-piperazine (419mg, 1.4mmol, 1.0 mol eq.) was prepared 1-(5-chloroindol-2-ylsulphonyl)-4-[4-

(6-oxo-1H-pyridazin-3-yl) benzoyl]piperazine(234mg) as an off white solid. ^{1}H NMR (300MHz, d_6-DMSO) 3.1 (s, 4H, under H_2O), 3.6 (bs, 4H), 6.9 (d, 1H), 7.0 (s, 1H), 7.3 (dd, 1H), 7.4 (d, 2H), 7.5 (d, 1H), 7.8 (s, 1H), 7.9 (d, 2H), 8.0 (d, 1H), 12.2 (bs, 1H), 13.1 (bs, 1H), signals were also present due to dichloromethane (1 mol equ.); MS $(MH)^-$ 496/498.

4-(3-1*H*-pyrazin-6-onyl)-benzoic acid was prepared by the method described by: Coates, W. J.; McKillop, A., *Synthesis*, **1993**, 334-342.